Claims

What is claimed is:

1. A semiconductor device, comprising:

a substrate;

first and second active regions disposed above the substrate;

a copper interconnect coupled between the first active region and the second active region; and

a barrier layer disposed under the copper interconnect, wherein the barrier layer comprises titanium, aluminum, nitrogen, and oxygen.

2. The semiconductor device of claim 1 wherein a composition ratio of the barrier layer is about 1:1.4:3.0:1.0 for titanium, aluminum, nitrogen, and oxygen, respectively.

3. The semiconductor device of claim 1 wherein the substrate is silicon.

4. The semiconductor device of claim 3 wherein the barrier layer limits migration of copper into the silicon.

5. The semiconductor device of claim 1 further including a silicide region formed in the first and second active regions and making electrical contact with the copper interconnect, wherein a portion of the barrier layer resides between the copper interconnect and the silicide region.

6. The semiconductor device of claim 1 further

including an oxide layer disposed between the copper interconnect and the substrate, wherein a portion of the barrier layer resides between the copper interconnect and the substrate.

7. The semiconductor device of claim 1 further including an adhesion layer disposed between the copper interconnect and the oxide layer.

8. A semiconductor device, comprising:

first and second transistors;

a metal interconnect coupled between an active region of the first transistor and an active region of the second transistor; and

a barrier layer disposed under the metal interconnect, wherein the barrier layer comprises titanium, aluminum, nitrogen, and oxygen.

9. The semiconductor device of claim 8 wherein a composition ratio of the barrier layer is about 1:1.4:3.0:1.0 for titanium, aluminum, nitrogen, and oxygen, respectively.

10. The semiconductor device of claim 8 wherein the metal interconnect is copper.

11. The semiconductor device of claim 10 wherein the substrate is silicon.

12. The semiconductor device of claim 11 wherein the barrier layer limits migration of copper into the silicon.

13. The semiconductor device of claim 8 further

including a silicide region formed in the active regions of the first and second transistors and making electrical contact with the metal interconnect, wherein a portion of the barrier layer resides between the metal interconnect and the silicide region.

14. The semiconductor device of claim 8 further including:

a substrate supporting the first and second transistors; and

an oxide layer disposed between the metal interconnect and the substrate, wherein a portion of the barrier layer resides between the metal interconnect and the substrate.

15. A method of making a semiconductor device, comprising:

providing a substrate;

forming first and second active regions disposed above the substrate;

forming a metal interconnect coupled between the first active region and the second active region; and

forming a thin film barrier layer disposed under the metal interconnect, wherein the barrier layer comprises titanium, aluminum, nitrogen, and oxygen.

16. The method of claim 15 wherein a composition ratio of the barrier layer is about 1:1.4:3.0:1.0 for titanium, aluminum, nitrogen, and oxygen, respectively.

17. The method of claim 15 wherein the metal interconnect is copper.

18. The method of claim 17 wherein the substrate is

silicon.

19. The method of claim 18 wherein the barrier layer limits migration of the copper into the silicon.

20. The method of claim 15 further including the step of forming a silicide region in the first and second active regions and making electrical contact with the metal interconnect, wherein a portion of the barrier layer resides between the metal interconnect and the silicide region.

21. The method of claim 15 further including the step of forming an oxide layer disposed between the metal interconnect and the substrate, wherein a portion of the barrier layer resides between the metal interconnect and the substrate.

22. A method of forming a thin film barrier layer on a semiconductor device, comprising:

placing the semiconductor device in a reactive sputtering chamber;

placing a titanium aluminum sputtering target in the chamber;

drawing a vacuum on the chamber;

introducing nitrogen and oxygen gases into the chamber;

dislodging particles from the titanium aluminum sputtering target;

reacting the particles with the nitrogen and oxygen gases within the chamber; and

depositing the thin film barrier layer containing titanium, aluminum, nitrogen, and oxygen on the semiconductor device.

23. The method of claim 22 wherein a composition ratio of the barrier layer is about 1:1.4:3.0:1.0 for titanium, aluminum, nitrogen, and oxygen, respectively.